Patients' self-assessment of oral malodour and its relationship with organoleptic scores and oral conditions.

UNIVERSITÀ DEGLI STUDI DI TORINO

PATIENTS' SELF-ASSESSMENT OF ORAL MALODOUR AND ITS RELATIONSHIP WITH ORGANOLEPTIC SCORES AND ORAL CONDITIONS

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Self-assessment of bad breath

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ABSTRACT

Objectives: The aim of this study was to compare patients' self-rating of oral malodour with organoleptic evaluation and to relate them to oral conditions.

Methods: One hundred eighty systemically healthy patients with a primary compliant of oral malodour participated in the present cross-sectional study. They were asked to complete a questionnaire regarding family and social discomfort and type of halitosis compliant, and to score the degree of their own oral malodour. The quality of the mouth air was assessed organoleptically by a calibrated odour judge. Odour-judge scores and self-assessments of bad breath were compared with one another as well as with clinical parameters (plaque index, bleeding index, probing depth and tongue coating score).

Results: The organoleptic test revealed that 93.9% of the subjects were found actually to have halitosis. The self-rating of oral malodour varied widely among patients. In 37.8% of patients there was a correspondence between subjective and organoleptic measurements. The better correspondence was evident at 2-3 scores. The organoleptic ratings were significantly related to clinical parameters, whereas patients' self- measurements did not. The bleeding index had the highest correlation coefficient among the periodontal parameters examined ($r = 0.665$, $P < 0.001$).

Conclusions: Self-estimation of bad breath correlated well with the presence of oral malodour as determined by organoleptic examination. Patients with slight or moderate oral halitosis presented the highest correlation rate between self- and odour-judge assessment.

INTRODUCTION

Halitosis has received considerable attention over the past few years because of its health and social implications (1). In the great majority of cases it results from the release of volatile sulphur compounds (VSCs) through putrefactive activities of predominantly anaerobic Gram-negative oral microorganisms (2). Bacteria associated with gingivitis and/or periodontitis are known to produce large amount of VSCs (3). However, actual evidence of the relationship between oral halitosis and periodontal disease is equivocal. Some investigations demonstrated an association beween the presence and the severity of periodontitis and the intensity of oral malodour (4,5), while others failed to confirm it (6,7). Differences in the criteria used to describe and quantify periodontal disease might parlty account for these discrepancies. Recent studies implicate the posterior region of the tongue as the main source of odour in both periodontally healthy and diseased individuals (8).

Patient's self-assessment of oral malodour is a complex issue. Cognitive, emotional as well as physiological factors can strongly influence the sense of smell (9). Genetic variations in human odorant receptors genes may account in part for variations among individuals in percepting odorants (10). Individuals suffering from bad breath are often unaware of it or become conscious because of the indications of others (11). On the other hand, some individuals are convinced to suffer from bad breath in spite no clinical basis can be found (12). The previous investigations demonstrated that subjects with a primary compliant of halitosis tended to overestimate their own malodour compared to an odour judge (11,13,14). Wheraes in the studies by Rosenberg *et al.* (11,14), patients were asked to rate the level of their own oral malodour by cupping their hand over mouth and nose, described in the investigation by Eli *et al.* (13) subjects were only requested to score on a visual analogue scale the level of bad breath they thought they had at that time. In addition, no data are available in the literature whether the degree of oral malodour may impact on mouth odor

self-assessment.

Another aspect to be considered is the method used for the clinical analysis of breath odour. Despite the introduction of instrumental analysis which involves sulfide monitors and gas chromatography, organoleptic test (OLT) still is the gold standard (15,16). Instrumental sensors are only useful for identifying VSCs, while OLT can detect and recognize compounds, and discriminates complex mixtures. In addition, it is the only method of assessing the degree of social offensiveness of breath odour (17).

Therefore, the aim of the present investigation was to compare patients' self-rating of oral malodour with organoleptic method and to relate them to oral conditions.

STUDY POPULATION AND METHODOLOGY

The study population included a consecutive series of 180 systemically healthy patients (mean age 47.54 ± 14.35 years, range 18-69 years; 77 females, 103 males) complaining of oral malodour and who arrived on their own initiative to the Division of Periodontology at the Dental School of the University of Torino, Italy, to evaluate their problem. The study was conducted over an 11-month period from January to October 2007. Exclusion criteria included individuals who had history of medical diseases (e.g. sinusitis, diabetes mellitus, kidney disease and hepatic cirrhosis, gastrointestinal disorders, respiratory dysfunctions, etc.) which are thought to be non-oral causes of halitosis, used antibiotics in the previous 4 weeks, wore complete or removable partial dentures, and had improper fixed prothesis or restorations (18). Women who were pregnant or breast-feeding were also excluded. Patients fulfilling the inclusion criteria were informed of the study and gave informed consent.

On the morning of the appointment for oral malodour assessment, the participants were instructed to refrain form using scenting personal products and from brushing their teeth. They were advised not to eat spicy foods or those containing onion or garlic 48 h prior to the appointment. They were also requested to refrain from eating at least 8 h before the visit and

from drinking 3 h before the examination. Additionally, they were asked to abstain from smoking, chewing gum, using any oral rinse and breath freshener at least 12 h before their appointment (19). This was essential in preventing dietary and cosmetic odour from influencing halitosis assessment.

Questionnaire

Patients completed a questionnaire regarding duration of bad breath, family and social discomfort, and type of compliant that initiated their referral for oral malodour evaluation. Three major complaints patterns were presented: individuals who perceived themselves as having a halitosis problem; those who became conscious because of the indications and/or attitudes of others; and those who both perceived themselves as suffering from malodour and have been told by others to have the problem.

Self- and odour-judge assessments

The degree of oral malodour was estimated by patients and by a single odour judge through an OLT. Patient's self-assessment was performed as described by Rosenberg *et al.* (11). Subjects were asked to smell the odour emanating from their mouth by cupping their hands over mouth and nose, exhaling through the mouth, and breathing in through the nose. They scored the level of their bad breath on a 0-5 point scale as follows: 0, no odour; 1, barely noticeable; 2, slight but clearly noticeable; 3, moderate; 4, strong; 5, extremely strong (20). Organoleptic measurements of whole-mouth malodour were made by a trained and calibrated odour judge who was blinded to any other data recorded during the study. Prior to the start of the investigation, 10 subjects were scored by the examiner of this study and another examiner. There was 98% agreement between them. A plastic tube was inserted into the patient's mouth, preventing the dilution of mouth air with room air. While the subject was exhaling gently through the mouth, the examiner judged the odour at the other end of the tube. Data were scored analogously to the subjects' self-assessment. Oral malodour was diagnosed if the OLT

scores were ≥ 2 (21).

Oral examination

Intra-oral and periodontal examination was carried out by the same calibrated investigator throughout the study. Participants were scored for plaque accumulation, presence of bleeding on probing (BOP) and probing depth (PD) at 6 points around each tooth by means of a Williams 0 probe. The mean PD, percentage of the sites with plaque (full mouth plaque score, FMPS), percentage of the sites with BOP positive (full mouth bleeding score, FMBS) were calculated for each subject. The diagnosis of gingivitis, moderate and severe periodontitis was made according to the criteria described by the American Academy of Periodontology (AAP) (22-24).

The tongue-coating score (TCS) was calculated by multiplying the thickness score by the area score (12). The area was reported as a score of 0-3 (0, no coating; 1, tongue coating covering less than 1/3 of tongue dorsum; 2, tongue coating covering 1/3 - 2/3 of tongue dorsum; 3, tongue coating covering greater than 2/3 of tongue dorsum). Thickness was reported as a score of 0 to 3 (0, no tongue coating: 1, thin tongue coating with papillae visible; 2, moderate tongue coating with papillae invisible; 3 thick tongue coating). The maximum value was 9.

The presence of pathology of the oral mucous membranes or attached gingivae was also recorded.

STATISTICAL ANALYSIS

The data were expressed as mean ± SD for all parameters assessed. Patients were grouped on the basis of the OLT scores. The Wilcoxon-signed rank test was used to compare the OLT values with the patients' oral odour scores. To determinate differences among the groups the Mann-Whitney rank test and the ANOVA were used when appropriate. Spearman's correlation coefficients were calculated to determine the association between oral malodour measurements and oral health. $P < 0.05$ was considered statistically significant.

RESULTS

All individuals enrolled in the study presented with a primary compliant of oral malodour. Forty-five (25%) perceived themselves as suffering from the problem, 64 (35.6%) were told by others, and 71 (39.4%) both. Fifty-eight (32.2%) subjects had previous professional visits to other clinics, mostly those of private dentists, physicians and otorhinolaryngologists. One hundred thirty-five persons (75%) reported having a problem with bad breath for several years, and 124 individuals (68.9%) complained about social and/or family discomfort.

Table 1 shows mean whole-mouth organoleptic scores and mean patients' self-rating oral odour scores distributed by clinical diagnosis. Among 180 individuals with a halitosis compliant 169 (93.9%) were diagnosed to have oral malodour based on organoleptic evaluation (scores 2-5), while 11 (6.1%) did not (score 0,1). The global oral organoleptic value was 2.85 ± 1.14 and was significantly lower than patients' self-rating odour score (4.01 ± 1.00, $P < 0.001$).

Table 2 reports the grading of oral malodour according to patients' self-assessment and OLT. As high as 85% of patients complained of a strong and socially unacceptable halitosis (scores 4 and 5), but only 33.9% were actually found to have a bad breath level of 4-5. In 37.8% of patients there was a correspondence between self- and odour-judge assessments, in 55% of cases the patients' evaluation was worse and in the remaining 7.2% it was better than the OLT scores. When data where split based on the level of bad breath, the better correspondence between patients' and organoleptic scores was evident at 2-3 scores (figure 1). Gender-based differences were found with regard to self-assessment of bad breath odour. In general, women gave a worse evaluation of their level of halitosis (66.2% versus 47.6% of men), while men were more objective (48.5% versus 32.5% of women).

In the group diagnosed with oral malodour (OLT ≥2), 108 subjects showed OLT scores of 2-3, 50 individuals had an OLT score of 4 and the remaining 11 patients of 5. On average,

FMPS and FMBS were 56.2 ± 19.8% and 51.7 ± 18.7% respectively. The mean PD amounted to 3.5 ± 1.1 mm and the mean TCS score to 4.1 ± 2.2. Eight subjects (4.8%) presented with periodontal health. Fifty-six individuals (33%) had gingivitis, 47 (27.9%) moderate periodontitis, and 58 (34.3%) severe periodontitis. Nobody had oral diseases.

When data were grouped on the basis of the intensity of oral malodour, subjects with OLT socre of 2-3 showed mean PD and TCS values of 3.1 ± 1.0 mm and 3.4 ± 1.6 respectively. Among individuals with with an OLT score of 5 the average PD amounted to 4.6 ± 0.7 mm and the mean TCS to 6.9 ± 1.8. Data from patients with an OLT score of 4 were intermediate (PD 4.1 ± 0.8 and TCS 5.8 ± 1.6). Probing depth and TCS values of the subjects with strong oral malodour were significantly higher than those of the individuals with slight or moderate bad breath ($P< 0.001$).

In the healthy (pseudohalitosis) group (OLT = 0 and 1) FMPS and FMBS amounted to 16.2 ± 3.3% and 14.2 ± 3.4% respectively. The mean PD was 2.2 ± 0.3 mm and the average TCS score was 0.8 ± 0.4. The differences between groups were statistically significant ($P< 0.001$).

Spearman's correlation coefficients showed that periodontal status as well as tongue coating were significantly associated with the odour judge measurements (FMPS, $r = 0.652$ $P<0.001$; FMBS, $r = 0.665$ $P<0.001$; PD, $r = 0.38$, $P= 0.003$; TCS, $r = 0.472$, $P<0.001$). No significant correlations were found between the same parameters and the patients' self-rating oral malodour (FMPS, $r= 0.123$ $P= 0.233$; FMBS, $r= 0.144$ $P= 0.309$; PD, $r= 0.134$, $P= 0.349$; TCS, $r= 0.133$, $P= 0.346$).

DISCUSSION

Data of the present investigation would suggest that patients' self-reporting of bad breath correlated well with the presence of oral malodour as determined by organoleptic examination. Among 180 individuals with a primary compliant of halitosis only 11 (6.1%) were found not to have oral malodour at all. Our data are consistent with those previously

reported by Iwanicka-Grzegorek *et al.* (25), but in contrast with those by Oho *et al* (12) and Iwakura *et al* (26) who observed a prevalence of pseudohalitosis ranging between 25% and 50%. It is noteworthy that in this investigation about 75% of the patients have been told by others to have a halitosis problem and about 30% had previous professional visits to other clinics. These findings could explain the high coincidence rate (93.9%) of halitosis with respect to patients' complaint.

Patients' self-assessment of oral malodour was carried out according to the method described by Rosenberg *et al.* (11, 14). Limit of this procedure is the possible interference between the odour of the exhaled mouth air and the hand skin.

We observed a wide range in the individual ability in scoring the own bad breath level. The average patients self-rating of oral malodour was significantly higher than the mean oraganoleptic scores. This finding would seem to suggest that patients were more sensitive to their own odour than a trained odour judge. However, when data were stratified on the level of oral malodour, in 37.8% of patients there was a correspondence between subjective and organoleptic evaluations, in 55% of cases the patients' perception was worse and in the remaining 7.2% it was better than the OLT scores. Patients with a lower degree of halitosis (2-3) showed more objectivity of self-estimation of their bad breath level. According to Eli *et al* (27), our data suggest that every patient has a a breath odour self-image. This self-image can range from little or no distortion to severe psycopathology. However, in the present investigation no psychological analysis was performed.

Few reports are available regarding the reliability of the self-assessment of oral malodour. Previous investigations by Rosenberg *et al* (11, 14) analysed only the statistical correlation between judge and self-assessments of breath odour without reporting either subjects' or organoleptic mean scores. They observed that patients' self-scores of whole mouth odour were not associated with odour judge measurements. Eli *et al* (13) reported the average

values of halitosis obtained through the use of OLT and patients' evaluation and compare them. They observed that subjects who are concerned about the problem are unable to score their own oral malodour in an objective fashion. However, no detailed analysis of data was provided.

We observed gender-based differences with regard to self-rating of bad breath odour. In general, women gave a worse evaluation of their level of halitosis, while men were more objective. It seems likely that females tend to be more anxious about bad breath than males (12) and to have a greater response to chemosensory stimuli (28).

Another aspect to be considered is the type of compliant made by patients about bad breath. It is interesting to point out that about 25% of the patients were self-conscious of oral malodour, 35.6% became conscious due to indications and attitudes of others, and the remaining 39.4 % both. Our data would seem to support the importance of the emotional variables in odours perception. When patients unaware of their own bad breath were asked to assess the level of their oral malodour they overestimate the degree of halitosis. McKeown (29) pointed out that our self-image is affected by what we perceive and by our interpretation of other people's perception of us within a social and cultural context.

In our study, the method for measuring oral the severity of oral malodour was the organoleptic examination. No instrumental analysis was performed. We were interested in assessing the social impact of malodour and in resembling day-to-day situations when halitosis is a cause for concern. Instrumental analysis of breath air is only useful for identifying VSCs, while real breath odour consists of a wide mix of odour molecules. The contribution of different volatile compounds and VSCs to an overall odour, detected in organoleptic evaluation, depends on odour threshold, odour power, and gas concentration (15). Therefore, the organoleptic method is suggested as the primary indicator of halitosis and is regarded as a kind of reference standard of oral malodour measurements although some

subjectivity is still expected even after a rigorous calibration (15,16,18,30-32). In this investigation a single odour judge assessed the participants. This is in agreement with previous reports (7,11,13,18,33), but in contrast with the American Dental Associarion (ADA) guidelines on oral malodour products that recommend two odour judges (34). Oral malodour measurements by a panel of judges introduce problems of reproducibility. Rosenberg and McCulloch (20) pointed out the difficulty in ensuring that the expelled mouth air had the same intensity and concentration of volatile compounds during sequential sampling. Therefore, in order to reduce the inherent subjectivity of the organoleptic method, prior to the start of this study the odour judge was calibrated against another examiner and there was a 98% agreement between their scores.

Organoleptic ratings were positively correlated with oral conditions, whereas no such correlation was found between periodontal parameters, tongue coating and patients' odour scores. Clinical studies comparing oral malodour and periodontal diseases have produced conflicting results. Several authors demonstrated highly significant association between organoleptic scores and periodontal disease-related parameters (2,4,5,35) while others failed to confirm it (6,7,36). In this study, the most striking associations were found for odour judge scores as compared with the bleeding index ($r= 0.665$, $P <0.001$) and the plaque index ($r= 0.652$, $P <0.001$). The mean PD, despite significantly correlated with OLT scores, displayed a lower correlation coefficient ($r= 0.38$, $P= 0.003$). These findings are consistent with previous clinical studies (2,33,37). They suggested that the existence of active inflammation in periodontal tissues is more important than the mere presence of deep periodontal pockets for oral malodour production. In addition, blood decomposition products themselves can also produce sulphur-containing peptides and aminoacids that are source of VSCs.

We observed a statistically significant association ($r= 0.472$, $P <0.001$) between whole-mouth organoleptic scores and tongue-coating status (presence and amount). This finding coincides

with those of previous reports (5,6,33,36). The TCS correlation coefficient was higher than the PD *r* value supporting that the dorsum of the tongue represents the primary source of VSCs, both in periodontally diseased and healthy individuals (8).

In conclusion, patients' self-reporting of bad breath correlated well with the presence of oral malodour as determined by organoleptic examination, while a wide difference in the individual ability in scoring the own bad breath level was observed. Patients with slight or moderate halitosis presented the highest correlation rate between subjective and organoleptic score.

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Table 1. Whole-mouth organoleptic and self-rating odour scores: comparison by clinical diagnosis

Clinical diagnosis	Number of patients (%)	Mean organoleptic score ± SD	Mean self-rating score ± SD	P value
Overall data	180 (100%)	2.85 ± 1.14	4.01 ± 1.00	<0.001
Oral malodour	169 (93.89%)	3.04 ± 0.95	4.00 ± 1.03	<0.001
Healthy	11 (6.11%)	0.27 ± 0.43	4.18 ± 0.40	<0.0001

Oral malodour = organoleptic score ≥ 2
Healthy = organoleptic score 0-1
$P < 0.05$ statistically significant

Table 2. Grading of oral malodour by patients' self-assessment and odour-judge assessment

	N° patients (%)	
Oral malodour score	**Self-assessment**	**Odour-judge assessment**
0-1	0 (0%)	11 (6.1%)
2-3	27 (15%)	108 (60%)
4	86 (47.8%)	50 (27.8%)
5	67 (37.2%)	11 (6.1%)

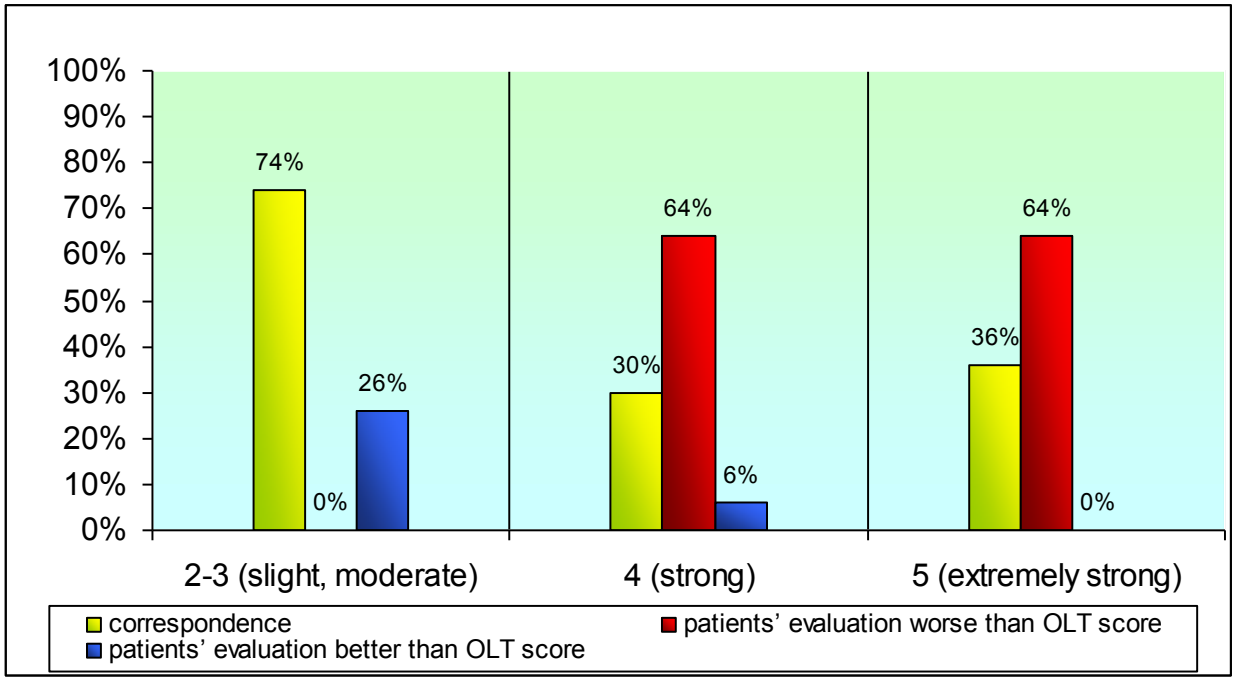

Figure 1: Correlation between patients' self-measurements and organoleptic (OLT) evaluation by odour scores.